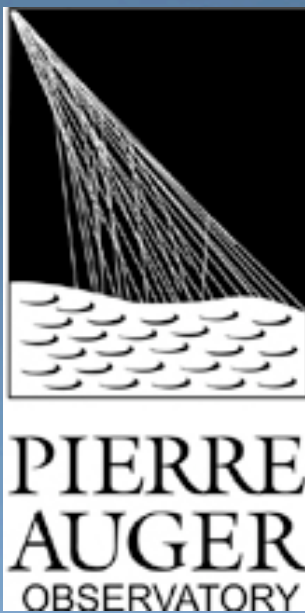


# Enhanced Auger South Observatory



Sein Eun-Joo Ahn (FCPA)



February 8th 2010 All Experimenters Meeting



# Southern Pierre Auger Observatory

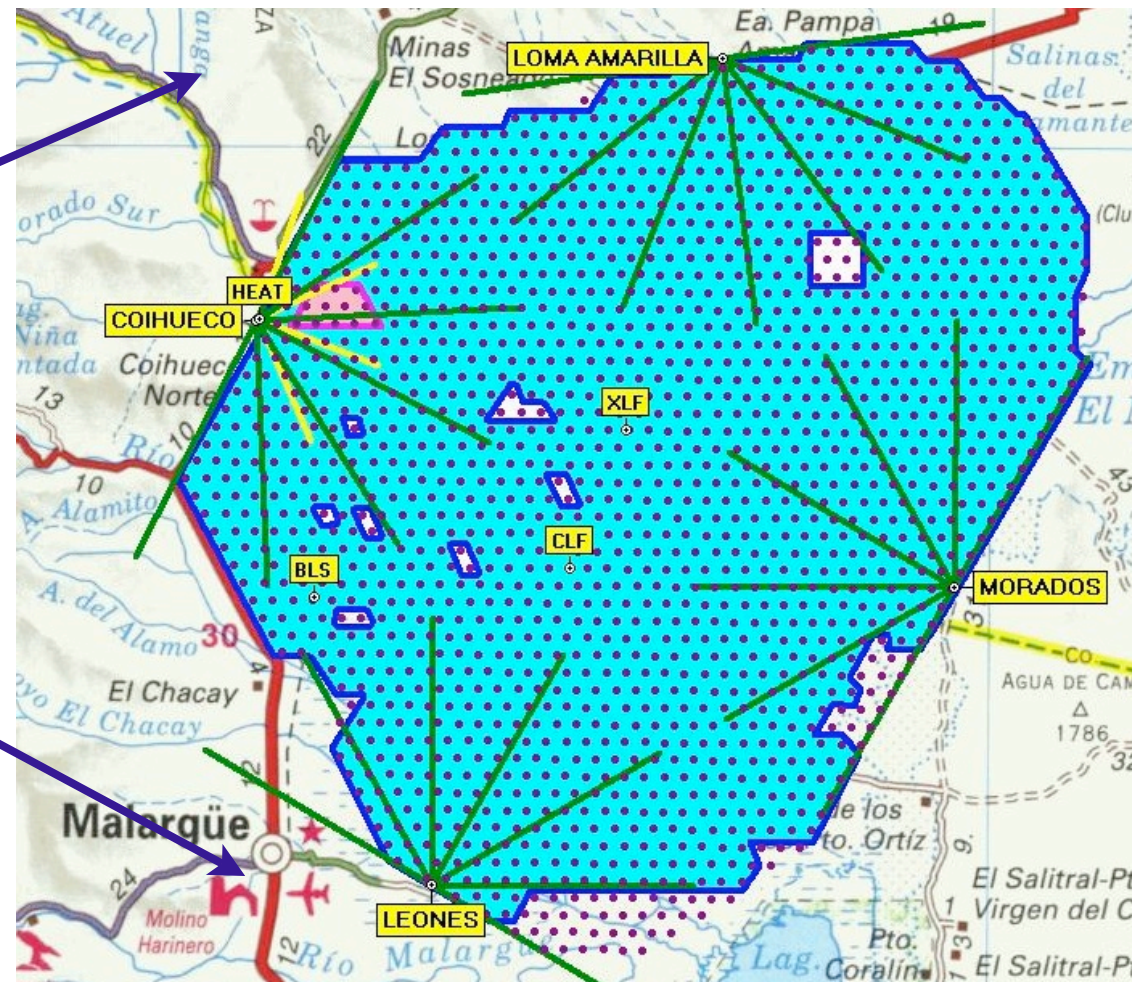
- Original surface and fluorescence detectors are complete
- Inauguration on 2008 November
- 476 scientists from 18 countries (13 at Fermilab)
- 16 peer-reviewed papers published (full collaboration)
- Enhancements under way



Loma Amarilla  
fluorescence enclosure

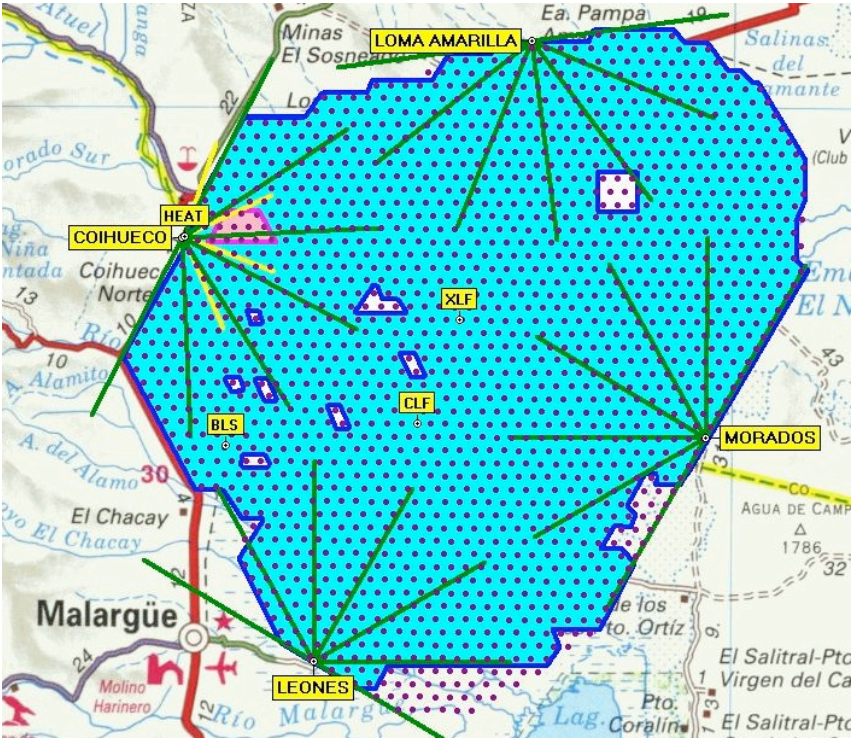


Tank 1600

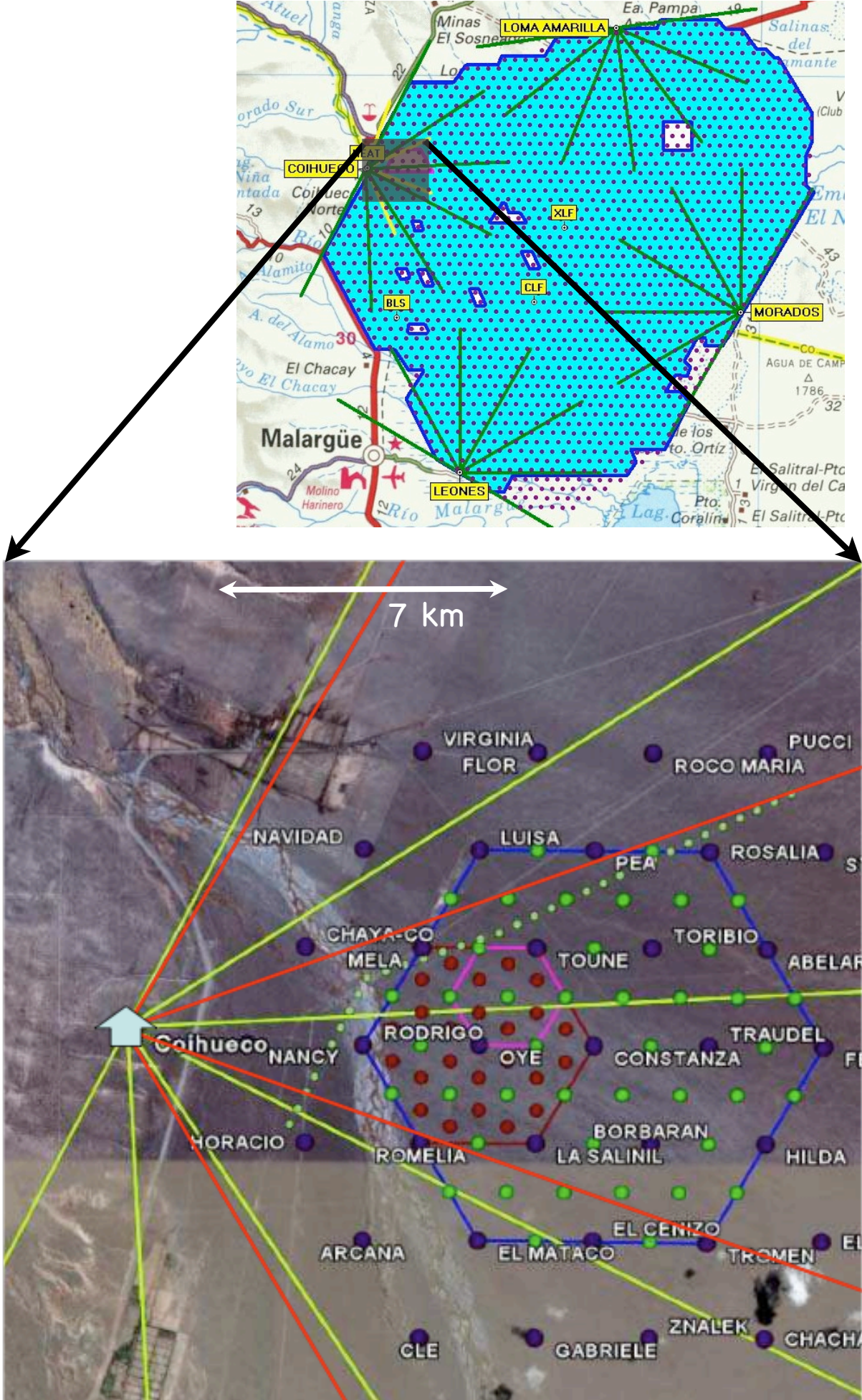




# Enhancements



# Enhancements





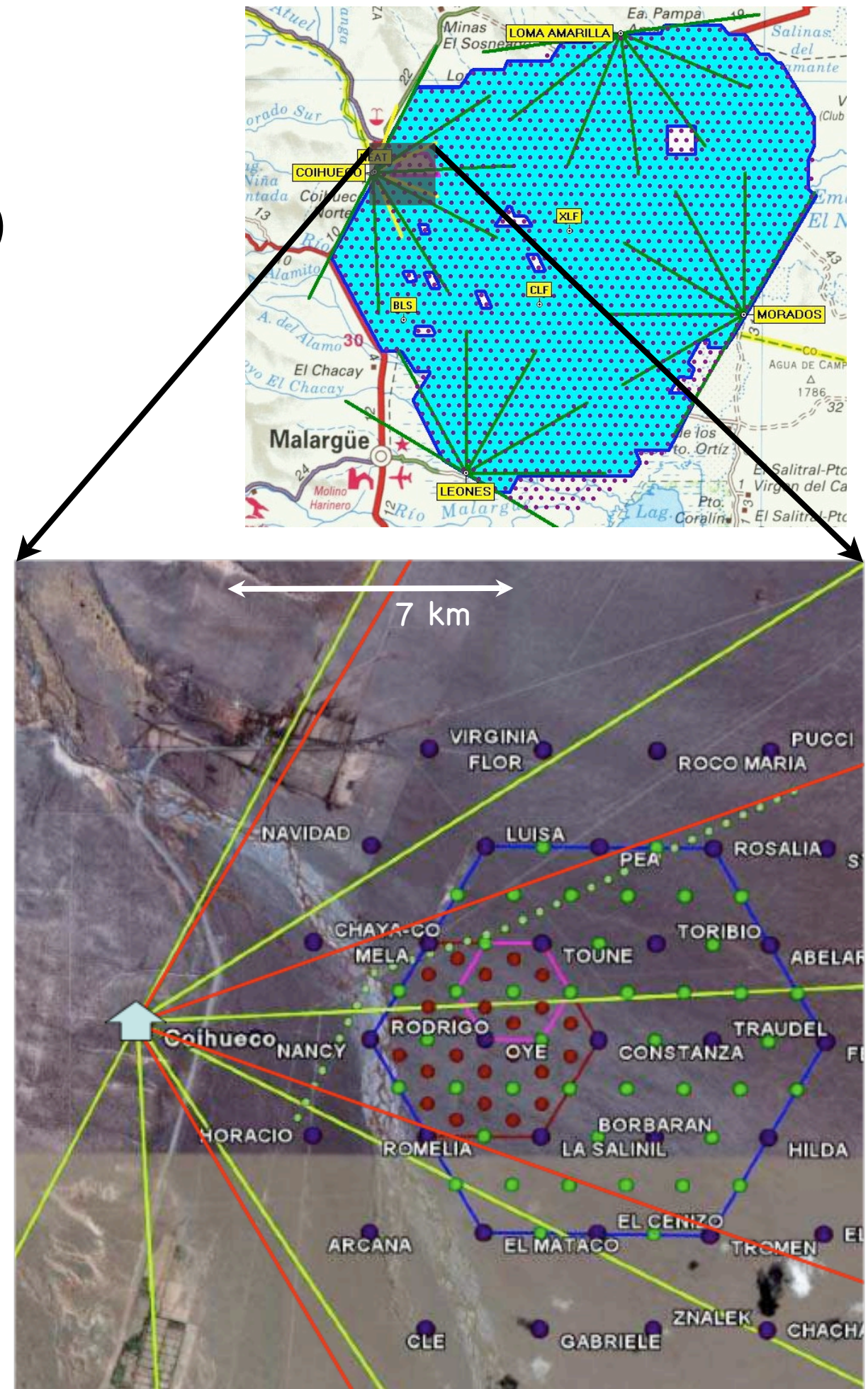
# Enhancements

1. High Elevation Auger Telescope (HEAT)

2. Muons and Infill (AMIGA)

Objective:

- extend observations down to lower energy
- obtain better composition information





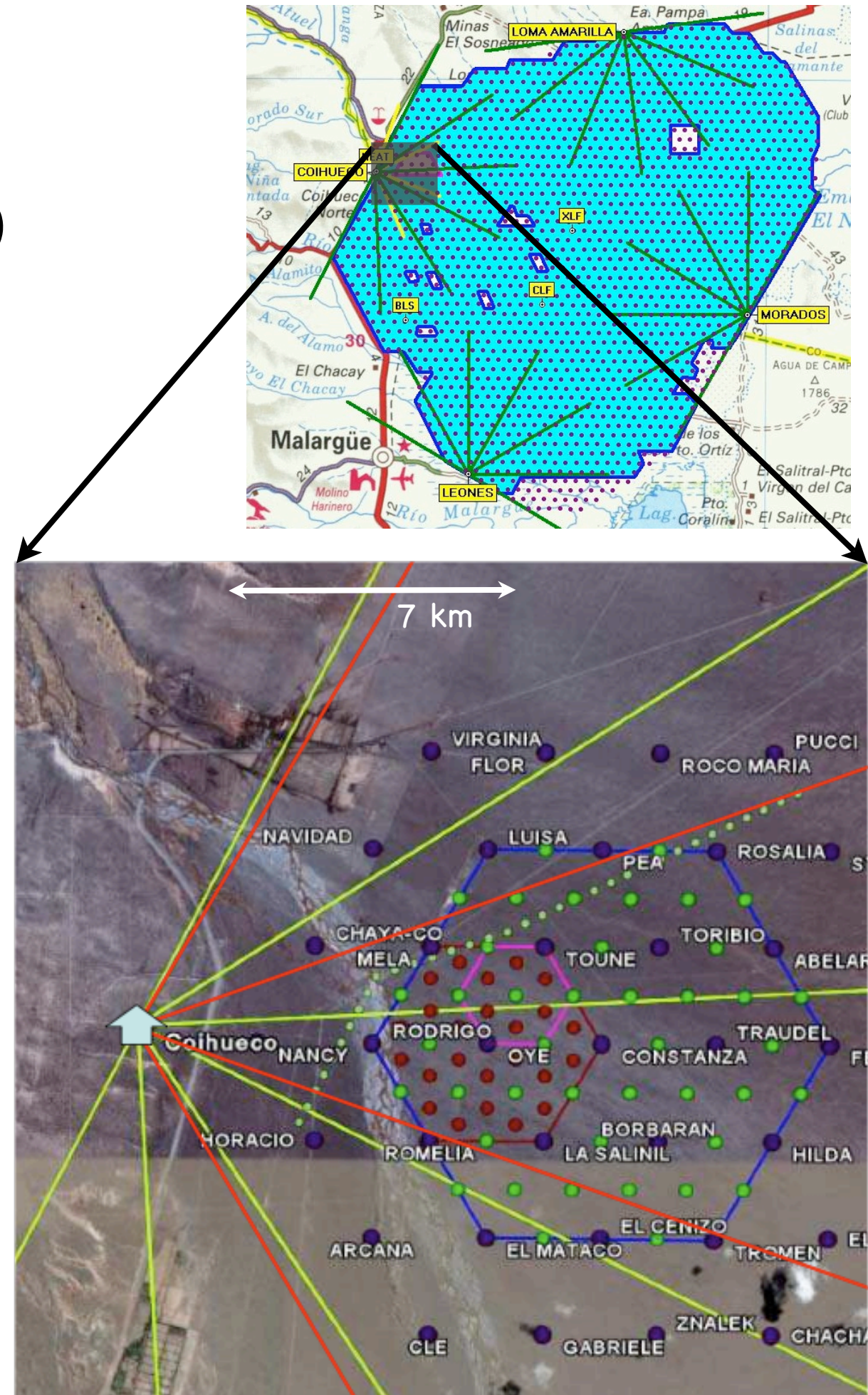
# Enhancements

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Infill + HEAT → low energy hybrid trigger





# Enhancements

## 1. High Elevation Auger Telescope (HEAT)

## 2. Muons and Infill (AMIGA)

Objective:

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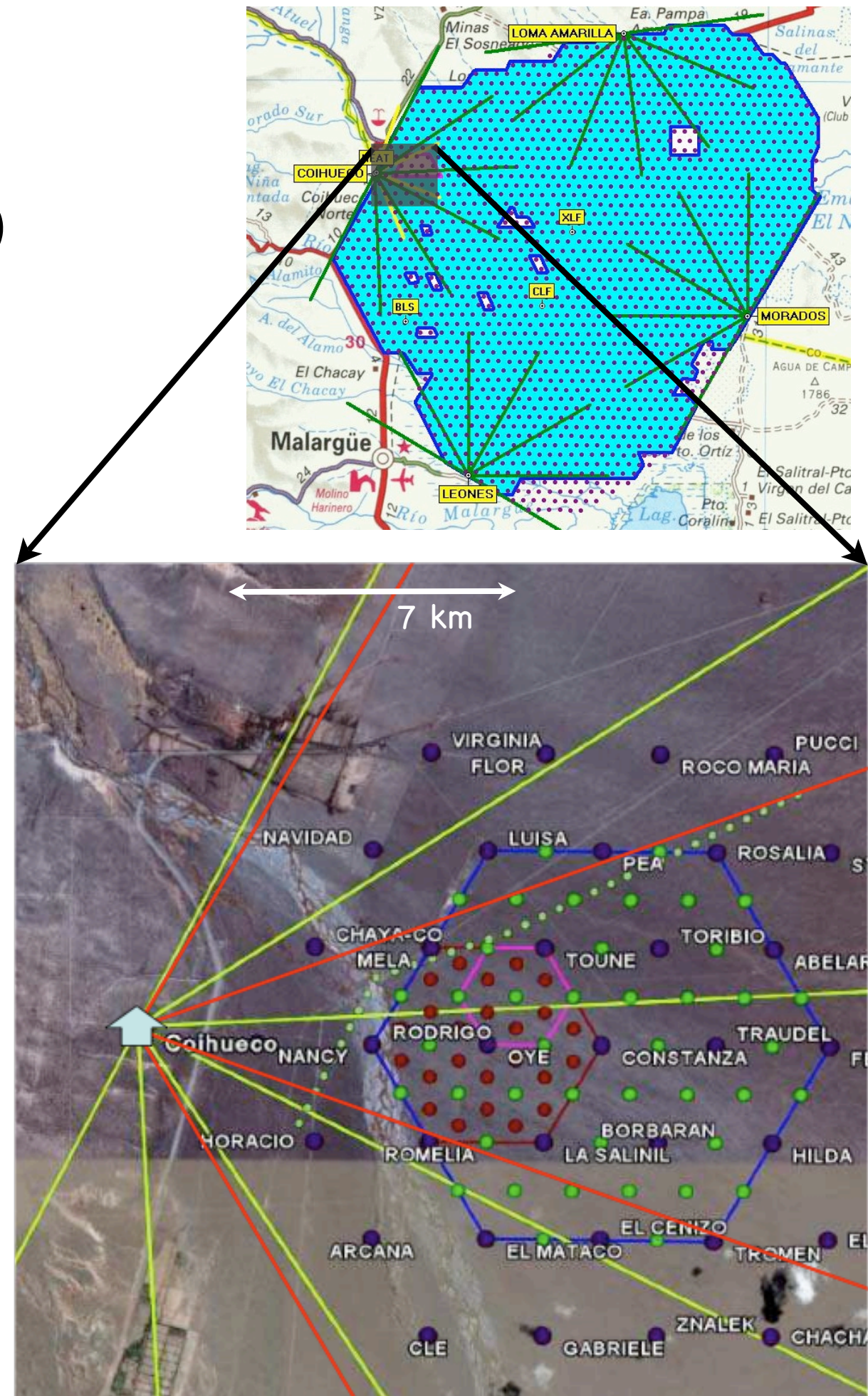
Infill + HEAT → low energy hybrid trigger

## 3. Radio R&D (AERA)

## 4. Microwave R&D

Objective:

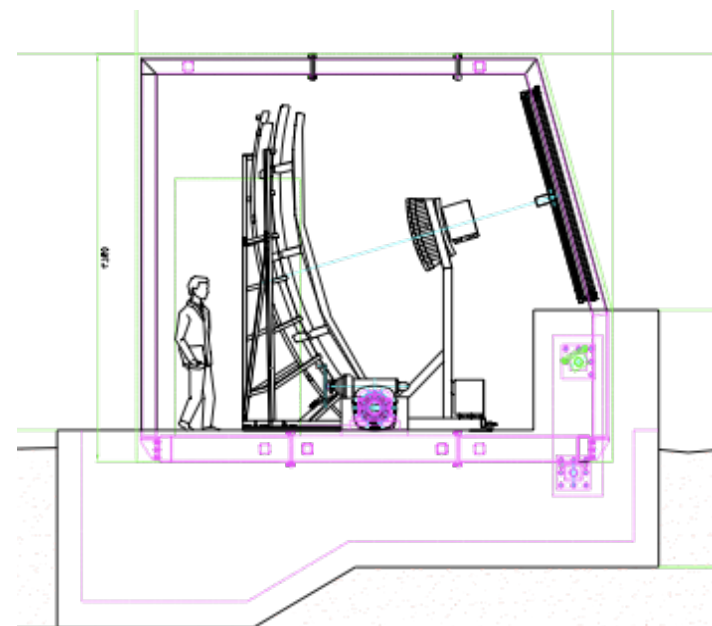
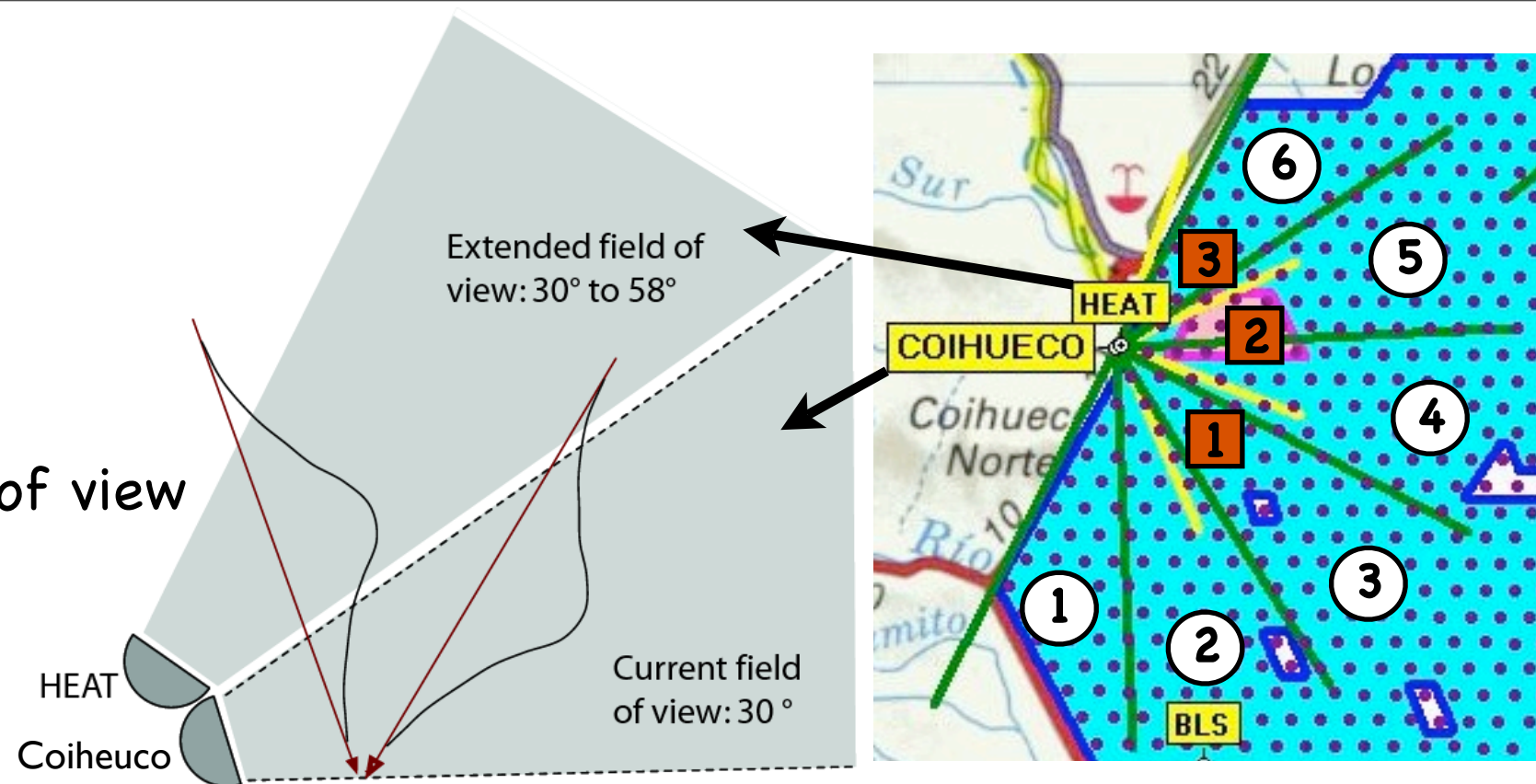
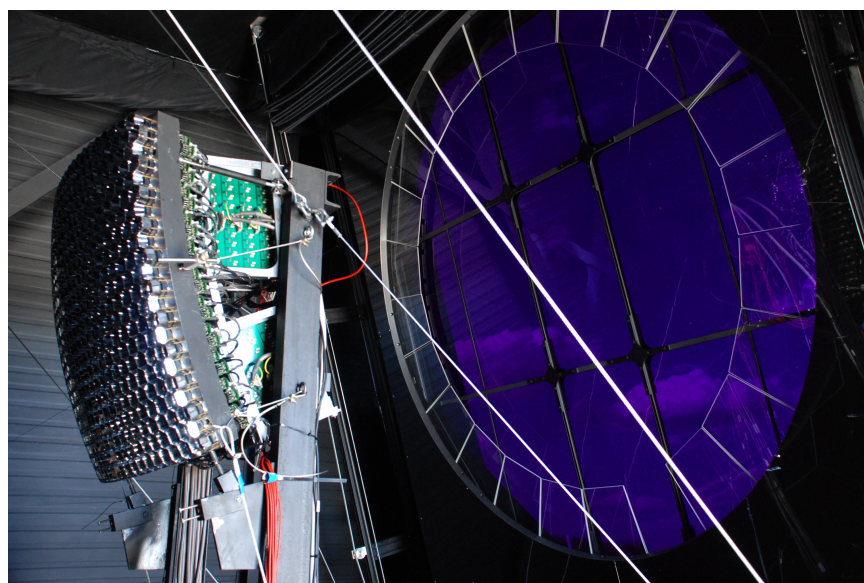
- complementary and cost-effective ways to detect CRs



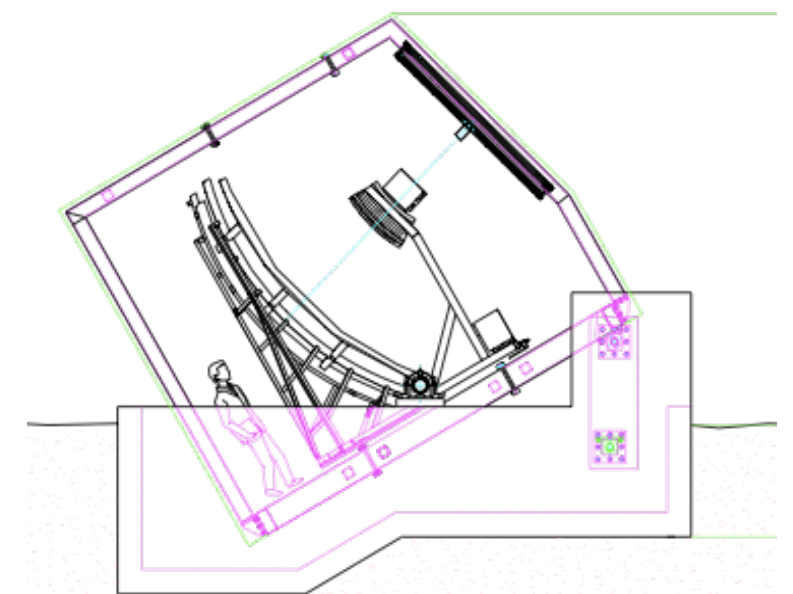


# 1. HEAT

- 3 tiltable telescopes
- Overlaps with Coiheuco FD
- 30°-58° elevation, extend field of view
- Energy  $\sim 10^{17}$  eV



Calibration & maintenance position



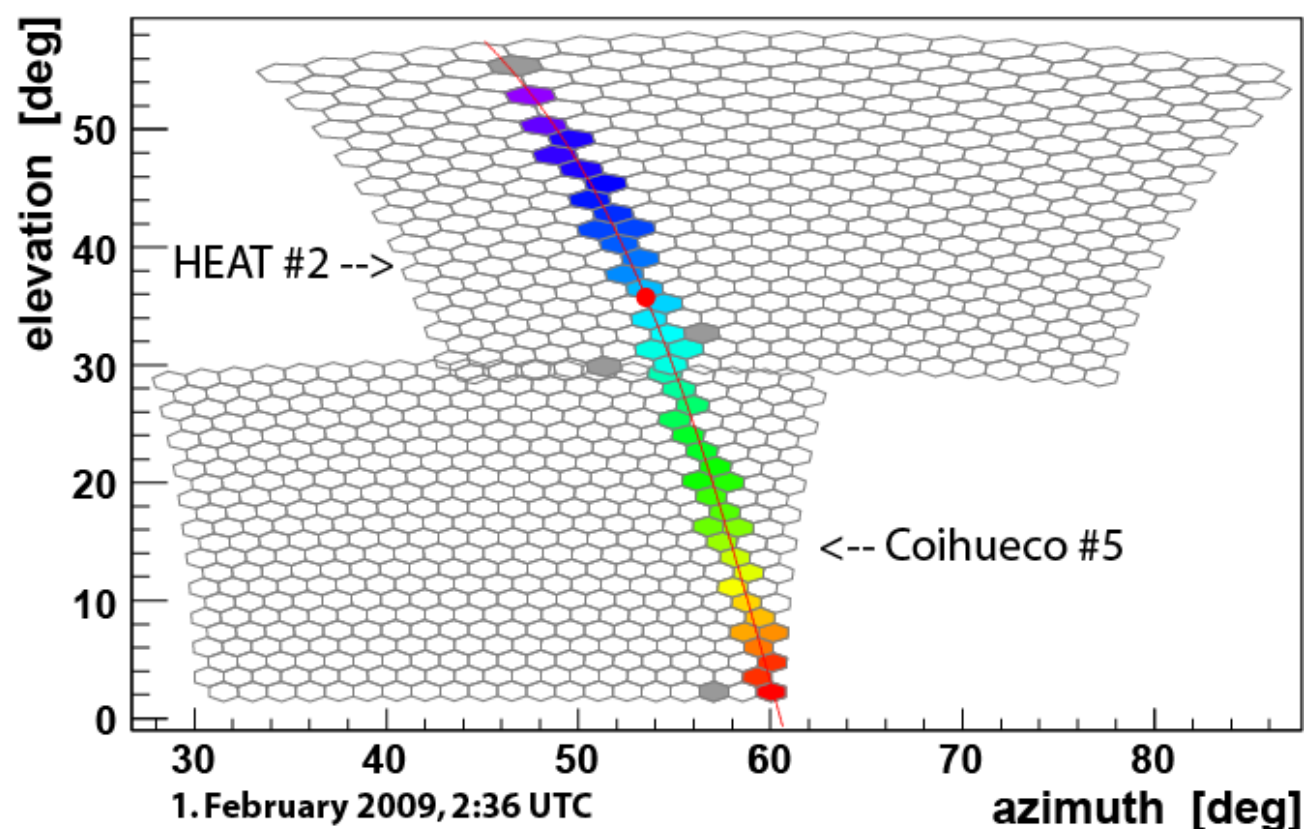
Data taking position

Can observe in both tilt and down positions



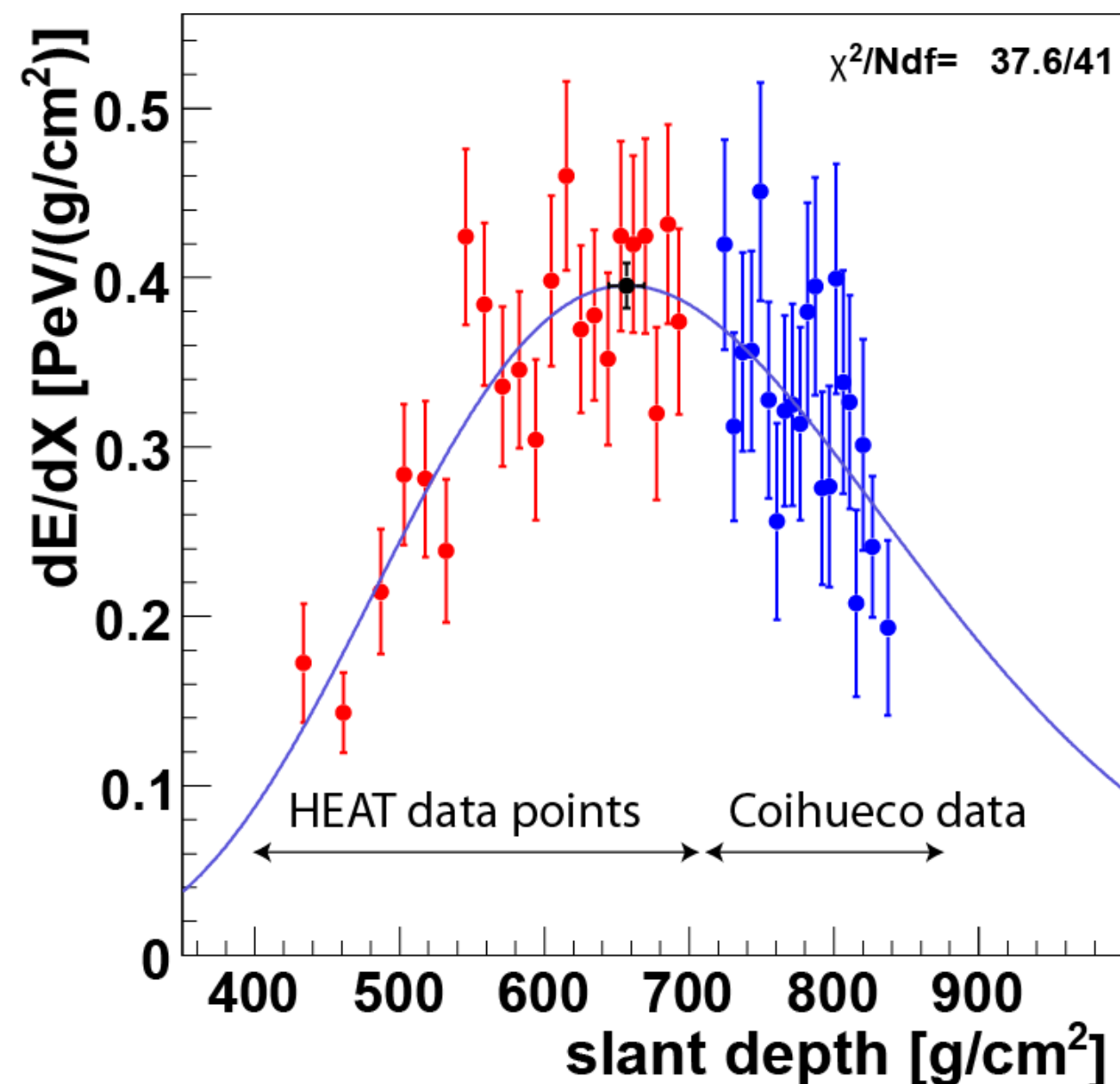
# First high quality hybrid event with HEAT

## Camera view with timing



- Shower triggered in both telescopes independently
- Timing well matched
- Reconstruction of  $X_{\max}$  requires combined data

## Shower profile



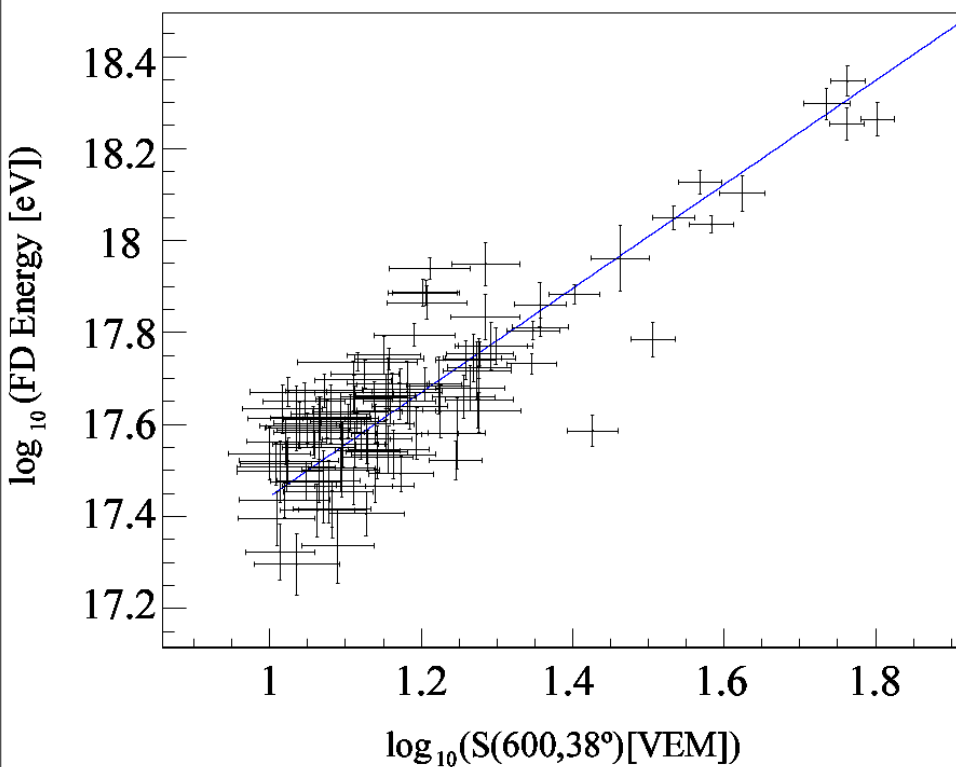
$$E = (2.0 \pm 0.2) \cdot 10^{17} \text{ eV}$$
$$X_{\max} = (657 \pm 12) \text{ g/cm}^2$$

Distance: 2.8 km to FD

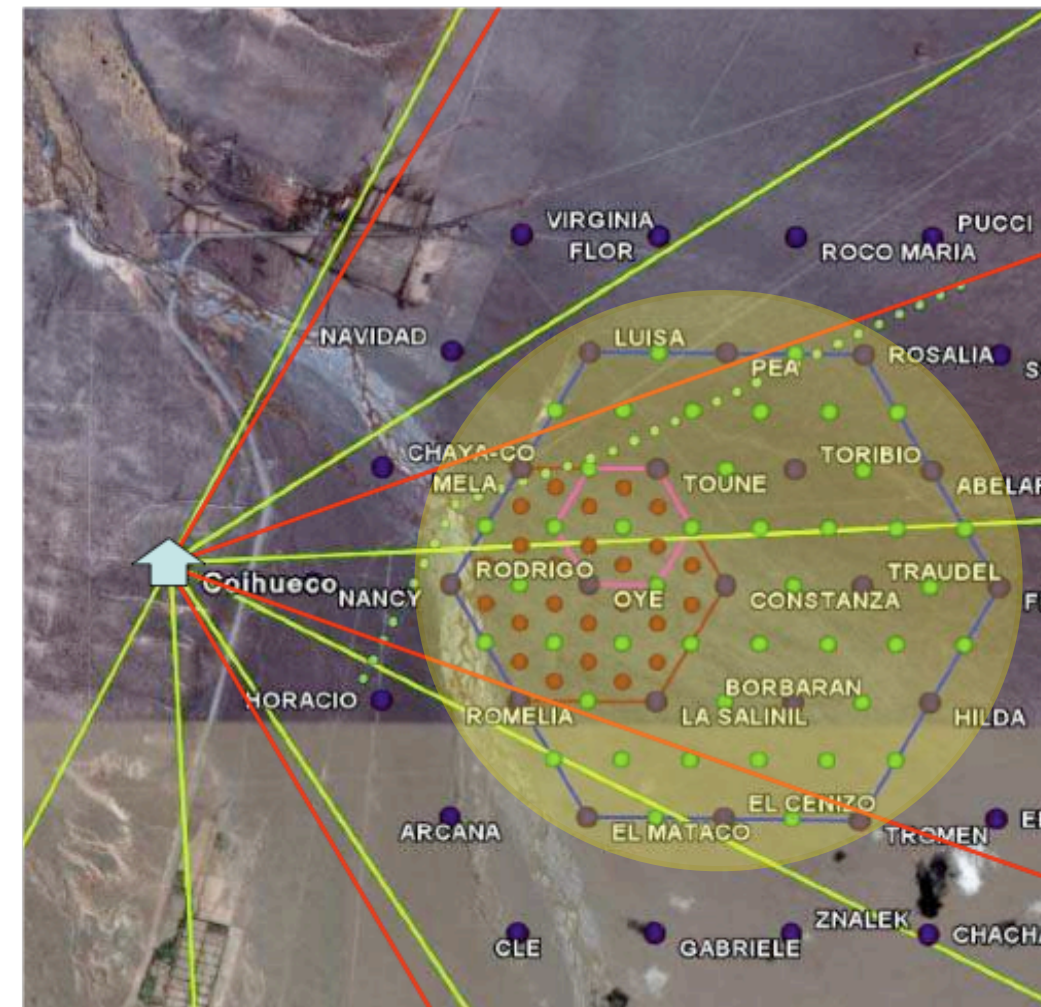


## 2. AMIGA (Auger Muons and Infill for the Ground Array)

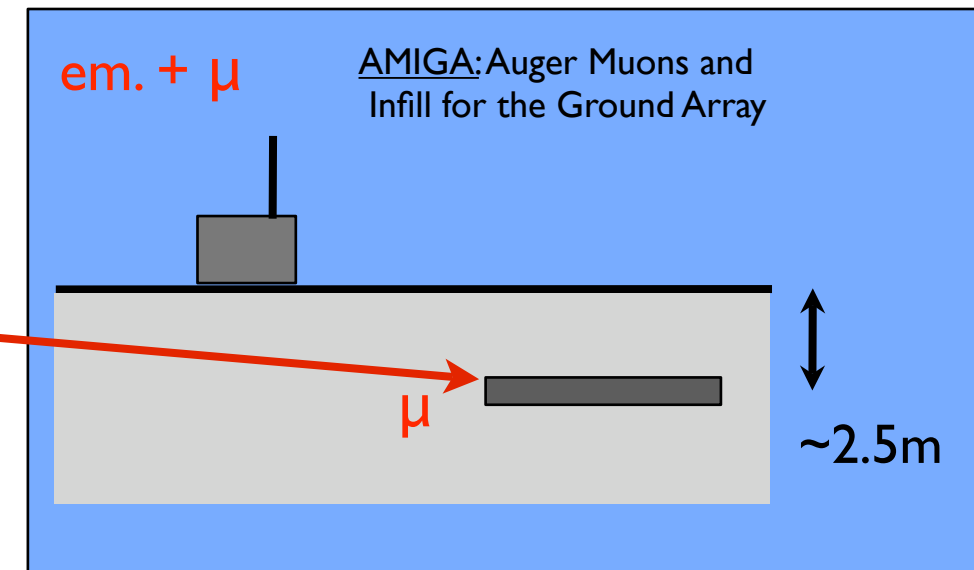
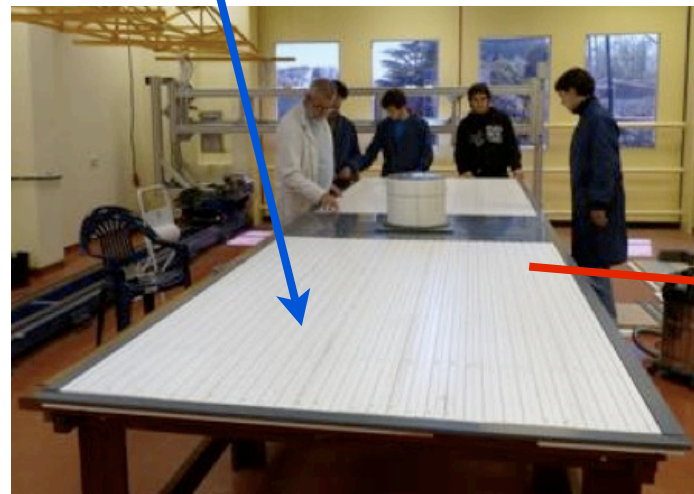
- 750m triangular grid
  - 61 water Cherenkov tanks +
  - 30 m<sup>2</sup> Minos-type scintillators underground
- Infill energy spectrum analysis in progress
- First muon detector buried in Nov 2009
- Deployment and analysis in progress



(more expected with HEAT)



scintillators from FNAL





### 3. AERA (Auger Engineering Radio Array)

- Coherent radiation from shower cascade
- 30–80 MHz
- Measure energy and composition
- Cost-effective, 100% duty-cycle
- Currently installing 24 stations over an area of 20 km<sup>2</sup>



(prototypes)

### 4. R&D on microwave detection

- Molecular bremsstrahlung by electrons in air shower with surrounding medium
- $\sim 4$  GHz
- Study ongoing at Ohio State Uni. and Uni. Chicago



# Summary

- Auger South array completed
- Enhancements in progress
  - better composition determination
  - lower energy  $\sim 10^{17}$  eV
  - 1. HEAT: 3 tilted fluorescence telescopes ( $30^\circ$ – $58^\circ$ )
  - 2. AMIGA: infill and muon detectors
- R&D on other ways to observe cosmic rays
  - 1. Radio: installation in progress
  - 2. Microwave